GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Master of Engineering

Level: PG

Branch: Geotechnical Engineering

Subject Code: ME02076071

Subject Name: Unsaturated Soil Mechanics

w.e.f.Academic Year:	2024-25
Semester:	2
Categoryof theCourse:	Professional Elective Course

Prerequisite:	Soil Mechanics, Mechanics of Solids
Rationale:	The knowledge of soil behavior is very important in the Geotechnical engineering practice. The soil behavior in saturated state is widely taught in the undergraduate and graduate programs, all over. The existence of air-phase in natural soils prompts the soil to behave differently from the saturated soils. The present course would provide the fundamental principles, mechanisms, and behavior of partly saturated soils and will develop understanding of soil behaviour and to apply it to develop elasto-plastic models based on unsaturated soil conditions.

Course Outcome:

After Completion of the Course, Student will able to:

No.	Course Outcomes
01	Understand the basic mechanisms of soil under specific conditions and demonstrate basic mechanisms behind index properties and tests on soil
02	Enhance the ability of relating the basic mechanisms of soil to behaviour of the soil under various loading and drainage conditions.
03	Apply the knowledge of application of the theory of elasticity and plasticity to characterize the soil behaviour.
04	Develop the understanding of soil behaviour and apply it to develop elasto-plastic models based on unsaturated soil conditions.

Teaching and Examination Scheme:

Teaching Scheme(inHours)			Total Credits L+T+(PR/2)	AssessmentPattern andMarks				TotalMarks
				Theory		Tutorial/Practical		
L	T	PR	C	ESE (E)	PA/ CA (M)	PA/CA(I)	ESE (V)	
3	0	2	4	70	30	20	30	150

Course Content:

Unit No.	Content	No.of Hours	% of Weightage
1.	Introduction: Unsaturated soil, Gravimetric and Volumetric water content, Pore water pressure, Matric and Osmotic suction, Soil Water Characteristic Curve (SWCC), Hysteresis in SWCC, Methods to determine SWCC	08	20
2.	Seepage in unsaturated soil: Permeability and Hydraulic Conductivity, Hydraulic Conductivity Function (HCF), One-dimensional steady state flow, Darcy's and Gardner's Principles, Transient Flow, Infiltration, Numerical Modelling, Capillary Barriers.	12	30
3.	Strength characteristics of unsaturated soil: Extended Mohr Coulomb's criterion, Shear strength and pore pressure parameters, Measurements of unsaturated shear strength parameters; Unsaturated shear strength models, Applications in Bearing Capacity, Lateral Earth Pressure, and Slope stability in Unsaturated soils	16	25
4.	Volume Change behavior of soils: Stress state variables for unsaturated soils, Stress Deformation Behavior, Volumetric continuity, Volume-Mass Constitutive Relations, Swelling and Collapse behavior.	12	25
	Total	**45**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
10	**20**	**25**	**25**	**10**	**10**

WhereR:Remember;U:Understanding;A:Application,N:AnalyzeandE:EvaluateC:Create(asperRevisedBloom'sTaxonomy)

References/Suggested Learning Resources:

(a) Books:

1. Murray E. J. and Shivakumar V., Unsaturated Soils: A fundamental interpretation of soil behaviour, Wiley-Blackwell, 2010, 1st edition.
2. Ning Lu and William J. Likos, Unsaturated Soil Mechanics, John Wiley & Sons Inc., 2004
3.Jean-Louis Briaud, Geotechnical Engineering: Unsaturated and Saturated Soils, John Wiley & Sons, Inc., New Jersey, 2013.
4. Murray E.J, Sivakumar V., Unsaturated Soils: A fundamental interpretation of Soil behaviour, Wiley-Blackwell, 2010.
5.Ng C.W.W and Menzies B, Advanced unsaturated soil mechanics and engineering, CRC Press, 2019.
6.Fredlund, D. J., Rahardjo, R., and Fredlund, M.D. Unsaturated Soil Mechanics in Engineering Practice, Wiley, 2012.
7. Lu, N. and Likos, W.J., Unsaturated soil mechanics, Wiley, 2004 (2)

(f) Open sources software and website:

1. NPTEL lecture series
2. MIT open source material

List of Laboratory/Learning Resources Required:

1.Sampling, Storage of unsaturated soil

2. Grain size distribution, Specific gravity, Atterberg limits, Permeability, Triaxial Test (volume change)

3.Direct and indirect suction measurement methods

4. Study soil-water characteristics

* * ** * **